REMARKS

The Final Office Action mailed on June 14, 2002, has been received and reviewed. Claims 33-37 and 41-56 are currently pending in the above-referenced application. Each of claims 33-37 and 41-56 stands rejected.

Reconsideration of the above-referenced application is respectfully requested.

Rejections Under 35 U.S.C. § 103(a)

Claims 33-37 and 41-56 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent 5,672,542 to Schwiebert et al. (hereinafter "Schwiebert").

M.P.E.P. 706.02(j) sets forth the standard for a Section 103(a) rejection:

> To establish a *prima facie* case of obviousness, three basic criteria must be met. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or combine reference teachings. Second, there must be a reasonable expectation of success. Finally, the prior art reference (or references when combined) must teach or suggest all the claim limitations. The teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art, and not based on applicant's disclosure. *In re Vaeck*, 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991).

Schwiebert teaches a method of using a stencil to form solder bumps on substrates. Col. 1, lines 9-14. Specifically, Schwiebert teaches placing a solder mask 326 with multiple apertures 330 onto a substrate 320. The apertures 330 of the solder mask 326 correspond to the locations of wettable regions 322 (i.e., contact pads) on substrate 320. Col. 6, lines 25-33; FIGs. 3A - 3D. A dollop of metal paste is "squeegeed" into the mask 326 apertures 330. Col. 7, lines 66-67; col. 8, lines 1-2; FIG. 3B. The solder paste is a metal powder mixed with a flux vehicle. Col. 8, lines 18-19. "The mask aperture 330 dimensions are generally (but are not required to be) somewhat larger than the dimensions of the wettable regions 322." Col. 7, lines 50-53. The solder paste is re-flowed by heating the entire substrate 320, mask 326 and solder paste assembly. Col. 9, lines 53-55; FIG. 3C. As the assembly is heated, the solder paste

metal spheres 334 melt and coalesce into a single sphere or solder bump 338. Col. 9, lines 55-57. An important feature of the process is that the mask remains in place during both the deposition and re-flow processes. Col. 6, lines 46-49; col. 10, lines 45-47. An additional requirement of Schwiebert is that the stencil surface and, in particular, the apertures 330 are wettable. Col. 7, lines 11-16. In other words, as the solder paste is liquified during the re-flow process, the formed solder bump 338 is repelled by the side walls of the aperture 330. The mask (i.e., apertures) serves two purposes by acting as a reservoir for the metal paste to be deposited and to "act as a dam . . . to contain the paste until and during the reflow process." Col 6, lines 40-45.

Schwiebert also teaches a bump-to-mask clearance given by the equation $c = (L - D)/2$, where L is the aperture 330 size and D is the re-flowed solder ball diameter. Col. 5, lines 44-52. Schwiebert illustrates the meaning of the bump-to-mask clearance equation in FIG. 1B and FIG. 3C, which depicts c as being the distance between an aperture 330 sidewall and the closest point on the surface of the solder bump 338. The surface to bump distance is greater than zero and, thus, the bumps 338 of Schwiebert are spaced apart from the sidewalls of the apertures 330 because Schwiebert teaches that there must be a minimum allowable bump to mask clearance for adequate stencil release, which is illustrated in FIG. 1B as c and is further supported by the preferred values for c provided in the table of mask/substrate/bump parameters. Col. 5, lines 64-65; col. 6.

It is respectfully submitted that Schwiebert fails to teach or suggest all the limitations of independent claims 33, 43 and 49. To establish *prima facie* obviousness of a claimed invention, all the claim limitations must be taught or suggested by the prior art. Moreover, all words in a claim must be considered in judging the patentability of that claim against the prior art. M.P.E.P. § 2143.03.

Each of independent claims 33, 43 and 49 recites a pre-formed solder mask that comprises polymer and that includes"at least one open aperture" which is "configured to define a peripheral shape of a conductive structure to be formed . . ." Independent claims 33 and 43 also recite that the at least one open aperture is located "correspondingly to a contact pad location of a

substrate upon which the pre-formed solder mask is to be disposed." Independent claim 49 similarly recites " a pre-formed film of solder mask material . . . and at least one aperture" formed therethrough. Accordingly, when the pre-formed solder mask of independent claims 33, 43 and 49, which comprises a polymer, is placed on the surface of the substrate having contact pads it already has the at least one open aperture formed therein, because the language "pre-formed" further suggests that the at least one open aperture is present when the mask is placed on the surface of the substrate.

It is asserted in the Final Office Action "the mask of the prior art is an independent entity separate from the substrate." Final Office Action, page 6, paragraph 1. However, this is not what the language used by Schwiebert teaches with respect to employing a polymer mask. Schwiebert states that "a polymer mask . . . applied to the surface of the substrate, with apertures formed by chemical, mechanical or plasma etching or laser ablating the desired size holes in the mask located above the wettable pads." (Emphasis supplied.) Col. 7, lines 24-28. Thus, the apertures are formed in the polymer mask above the wettable pads after the mask is placed on the surface of the substrate. This is in contrast to the invention recited in independent claims 33, 43 and 49 because each of independent claims 33, 43 and 49 recites that the at least one open aperture is already in the polymer mask prior to placement thereof on the substrate.

Therefore, Schwiebert neither teaches nor suggests a pre-formed solder mask comprising a polymer with at least one open aperture that is located correspondingly to a contact pad or contact pad location of a substrate, as recited in independent claims 33, 43 and 49.

Independent claims 33, 43 and 49 also recite "at least one open aperture configured to define a peripheral shape of a conductive structure." (Emphasis supplied). It is asserted in the Final Office Action that "any opening on a mask indeed defines a peripheral region of contact area for which it is designed." Final Office Action, page 5, paragraph 5. Applicant respectfully disagrees. The plain meaning of the language "peripheral shape" refers to the external boundary or surface of the conductive structure. Thus, the at least one aperture serves as more than just a dam to hold the solder within the aperture, it serves as a mold to give structure to the conductive

material extending above the contact pad. By contrast, Schwiebert teaches that the aperture 330 is limited to "two purposes," one is a reservoir to hold the solder paste and the other is a dam to contain the paste during the re-flow process. Col. 6, lines 40-45. When formed, the solder bumps 338 are spaced apart from the sidewalls of the apertures 330. *See, e.g.,* FIG. 1B. There is no mention anywhere in Schwiebert that the aperture 330 is used to define, mold, shape or form the peripheral shape of the solder bumps 338. Schwiebert does state "that the mask aperture may be oblong and the BLM [i.e., wettable regions 322] circular or octagonal . . . [and that] upon reflow, the solder becomes spherical on the BLM [i.e., wettable region 322] circular pad." Col. 7, lines 55-57. This statement indicates that the peripheral shape of the solder bump is not defined by an aperture of a solder mask but, rather, by the shape of the wettable region upon which the solder bump is formed. Since the solder bump is in a liquid state as it forms and adheres to the wettable region 322 and the aperture 330 is not used to shape or mold the solder bumps region above the wettable region 322, the solder bump assumes the lowest energy configuration, which is a rounded or spherical shape. The result is a solder bump with a bottom edge having the shape of the wettable region 322 and the region of the solder bump above the wettable region 322 being rounded or spherical.

Therefore, Schwiebert neither teaches nor suggests a pre-formed solder mask which comprises polymer and which includes at least one aperture which is configured to define the peripheral shape of a conductive structure, as recited in independent claims 33, 43 and 49.

Furthermore, the teachings of the Schwiebert patent are not sufficient to render the claims of the present invention *prima facie* obviousness because the proposed modification would change the principle of operation of the Schwiebert invention. The principle of operation of the Schwiebert patent is two-fold. First, the mask 326 apertures 330 serves as a reservoir for solder paste, and second, the mask 326 apertures 330 serve as a dam to retain the liquid solder bump 338 as it forms during the wetting process. Col. 6, lines 40-45. By contrast, the apertures disclosed in independent claims 33, 43 and 49 serve to define a peripheral shape of the

conductive structure (i.e., provide a mold for the conductive material) and place the conductive structure on a substrate contact pad.

Even assuming, *arguendo,* that the apertures 330 in Schwiebert could be modified to define a peripheral shape, there is no suggestion or motivation to do so. The solder paste placed into the aperture 330 contains both conductive metal powder (conductive material) plus a flux vehicle. Col. 8, lines 18-19. As the solder paste is melted, the metal powder coalesces into a solder bump 338. Col. 9, lines 55-56. As a result, the liquid flux vehicle is displaced to the region between the aperture 330 and the surface of the solder bump 338, filling the space known as the bump to mask clearance, c. The solder bump 338 formed in this liquid environment takes on a rounded or spherical shape above the wettable region 322 because there are no forces exerted by the rigid side walls of the aperture 330 on the surface of the solder bump 338.

Therefore, there is no suggestion or motivation to modify the apertures disclosed in Schwiebert to define the peripheral shape of the conductive structure recited in claims 33, 43 and 49.

It is further asserted in the outstanding Office Action that claims 34 and 44 are obvious because, in FIG. 3D of Schwiebert, "the lower surface of the contact material (338) falls directly on the contact area over the substrate avoiding the peripheral area of the contact area." Final Office Action, page 3, paragraph 2. Applicant respectfully disagrees. First, from the illustration presented in FIG. 3D is difficult to determine whether or not contact material 338 avoids the peripheral areas of the contact area. Second, when the aperture 330 is filled with paste 334, the flux vehicle contains flux which is in contact with the peripheral areas of the contact area because the aperture is somewhat larger than the contact area. Col. 7, lines 50-53. The flux acts to remove oxides from the entire contact surface, including peripheral and non peripheral surfaces, preparing it for solder adherence. Next, as the solder paste is melted, it forms a relatively uniform, smooth, unbroken, and adherent film of solder to the contact surface (i.e., the solder wets the entire exposed contact surface). The solder does not discriminate between

peripheral and non peripheral surface as long they have been acted upon by the flux and are exposed to the solder material, as is the case with Schwiebert.

It is asserted that claims 35 and 45 are obvious because "the height of the apertures dictate terms as to the height of the conductive structures formed through the holes since the conductive material cannot exceed the height of the mask. Anything beyond that height is the active contact region of the contact material." Applicant respectfully disagrees. Column 6 of Schwiebert presents a table of preferred embodiment mask/substrate/bump parameters clearly showing that the final solder bump height h (measured from the base of the solder bump to the top of the solder bump) exceeds the mask thickness t.

It is asserted that claims 48 and 56 are obvious because "the abstract teaches that the mask remains attached to the substrate during the reflow clearly suggesting adherence between the substrate and the mask at least until the process of reflow is complete." Applicant respectfully disagrees. It is respectfully submitted that there is no language in the abstract to suggest use of an adhesive material to adhere the mask and substrate surfaces together. The language "remains attached" is broad and could be used to reference any number of ways in which to attach the mask to the substrate, which may include, without limitation, bolting, tying, static electricity, and chemical bonding. Schwiebert does teach use of magnets 548 to adhere the surfaces together but makes no mention of an adhesive material for that same purpose. Col. 7, lines 38-42.

In general, because independent claims 33, 43 and 49 have been shown above to be nonobvious under 35 U.S.C. §103, claims 34-37, 41, 42, 44-48 and 50-54 are nonobvious, among other reasons, as depending therefrom. M.P.E.P. §2143.03 (*In re Fine*, 837 F.2d 1071, 5 USPQ2d 1596 (Fed. Cir. 1988).

CONCLUSION

Claims 33-37 and 41-56 are believed to be in condition for allowance, and an early notice thereof is respectfully solicited. Should the Examiner determine that additional issues remain which might be resolved by a telephone conference, he is respectfully invited to contact Applicants' undersigned attorney.

Respectfully Submitted,

Brick G. Power
Registration Number 38,581
Attorney for Applicants
TRASKBRITT, PC
P.O. Box 2550
Salt Lake City, Utah 84110
Telephone: (801) 532-1922

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